Forest Insects & Disease (Nonnative Species)

Introduction

The National Park Service is charged with preserving natural resources including forces that cause ecological change such as forest insects and disease. However, when humans have either intentionally or unintentionally introduced species into an area outside of a species' natural range, the Service strives to control or eliminate that species. Thus the Service allows fall cankerworm, elm leaf beetle, and shoestring root rot (all natives) to run their course but gypsy moths and hemlock woolly adelgid (both nonnatives) are controlled or managed at some level.

Bacillus thuringiensis (Btk) being sprayed in selected areas of Shenandoah National Park in the Spring of 2008 to help control Gypsy Moths.

Gypsy Moth

The European gypsy moth (Lymantria dispar) was introduced into the United States in 1869. Since then, it has been a significant pest to hardwoods in the eastern United States and parts of the Midwest. Oaks are the preferred host species for feeding caterpillars, but a variety of other hardwoods and some conifers are also consumed.

Female gypsy moths lay eggs as fuzzy, tan egg masses in mid- summer. Late, the following April, larvae emerge from the eggs and climb to the upper reaches of trees. They drop on silk- like treads and are dispersed by the wind. Feeding begins. Gypsy moths prefer the white oak group but will feed on approximately 400 species of plants. After feeding and passing through several larval stages, the caterpillars will pupate in June and July. After two weeks they will emerge as adult moths. Shortly thereafter, the moths mate. Once the female has laid her eggs she will die. Male moths live about one week after emerging from the pupae.

The gypsy moth (GM) arrived at Shenandoah National Park (SNP) in 1981. Early during its spread, it was determined that over 85% of the Park's forest cover contained trees which were the preferred food of GM larvae. Serious GM defoliation began in the northern part of the Park in 1986.

GM suppression goals at the Park focused on protecting sensitive historic areas, protecting endangered Shenandoah salamander (Plethodon shenandoah) habitat, and providing a visitor safety corridor along Skyline Drive and other developed areas. These areas encompassed 4.7 % of the Park. It was recognized that these suppression goals would not eliminate gypsy moths from the Park at large, but would minimize their impacts in those locations.

The vertical wasted cadaver is Entomaphaga fungus mortality and the V-shaped cadaver is NPV virus. It illustrates that both these agents played an important role in GM late-stage larvae mortality in the park in 2008.

For a 10- year period (1986- 1995), Park suppression activities included mechanical, biological, and chemical controls (the majority of aerial treatments consisted of using Bacillus thuringiensis (B.t.) and Dimilin). During this time, many oaks were lost due to gypsy moth- related mortality. The added stress of drought in the late 1980s caused even higher mortality, especially in the northern half of the Park. In some parts of the Park, oak mortality was so pronounced that over 50% of the forest over story was killed (where oaks represented roughly 60% of the forest cover type prior to GM).

The Park GM population collapsed between 1995- 1996 due to the activity of the fungus, Entomophaga maimaiga. This fungus was first introduced in the early 1900s to control the GM. In 1990, it reappeared or was inadvertently reintroduced. By 1996, this fungus had established large populations in the environment. As a result, in 1996, there were virtually no areas of the Park or Virginia that experienced GM defoliation. Since 1996, the fungus has been very effective at keeping GM populations at relatively

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low levels. However, like most organisms, Entomophaga has boom and bust years. Poor Entomophaga years are usually preceded by drought. In 2008, SNP experienced 11,750 acres of defoliation – the highest defoliation year since 1995 (See figure below).

In late June 2008, the heavily defoliated areas in the park were showing high mortality of late instar GM larvae due to Entomaphaga fungus and the NPV virus.

Though resource impacts from gypsy moths in SNP were many and the administrative costs very high for suppression, it does not appear that the pest caused irreparable harm. Defoliation and tree mortality contributed to the diversification of species and age classes within the forest and may have left it better able to withstand future stresses.

Hemlock Woolly Adelgid

Hemlock woolly adelgid (Adelges tsugae)(HWA) was introduced to the United States in 1924 in California, and reached Richmond, Virginia in 1953. This exotic pest was first discovered in the Park in January 1988. It is currently found throughout the mountainous regions of the Blue Ridge and Allegheny Mountains from New England to the Carolinas.

HWA lays eggs during February and March and again in summer. Hatches occur in March and July. They reside on the underside of branchlets of eastern hemlock and Carolina hemlock trees, at the base of the needles, and typically they stay there all their lives. HWA are present throughout the year but are most visible from January through April due to their formation of tiny white cottony sacs or egg masses. The adelgid (similar to aphids) feeds on the starch of hemlock trees. The sap sucking robs hemlock trees of strength and causes them to lose needles. Needles begin to fall off as the tree attempts to protect itself from the lack of starch. Once established, the adelgid steadily increase their numbers on a given tree. After several years of this activity, the hemlock usually succumbs.

Typically, hemlocks cannot survive beyond four- to- six years of infestation. Mortality occurs much quicker if the infestation is accompanied by drought (e.g., Limberlost from 2000- 2002). Trees receiving fifty percent or more needle defoliation will eventually die. Hemlocks do not refoliate effectively like hardwoods. Heavy infestations of HWA on eastern hemlock trees throughout the Park have progressively led to crown health decline and widespread tree mortality. It is estimated that 90% of the Park's hemlocks have already succumbed to the adelgid.

The best approach to management of HWA is early intervention, before the tree crown is impacted. After initial detection in 1988, Park staff members began monitoring to determine distribution of the adelgid and to assess tree health. Control measures were undertaken in the Park in 1992 and what followed was a 3- year period of testing different techniques. HWA control measures were standardized in 1996. Parkwide control is not operationally or economically feasible, therefore the primary management objective is to preserve some of the hemlock gene pool within the Park for the purposes of future species restoration. To date, areas that contain relatively healthy hemlocks include the Skyland, Whiteoak Cabin, Big Meadows, Hawksbill, and Stony Man areas. Trees within these areas are being treated via soil injection with the systemic pesticide Imidacloprid. Annually, the park treats 900- 1300 trees each treatment having efficacy for about three years.

Loss of eastern hemlocks from Shenandoah will be unfortunate in and of itself but loss of the cool, moist community and related plants and animals associated with eastern hemlocks will clearly demonstrate the devastating consequences of exotic species encroachment.

Hemlock woolly adelgids (Adelges tsugae) on a hemlock branch. Photograph by Dennis J. Souto, USDA Forest Service, www.forestryimages.org.

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Gypsy Moth defoliation by year in Shenandoah National Park (top). Hemlock crown health classes by year (bottom).

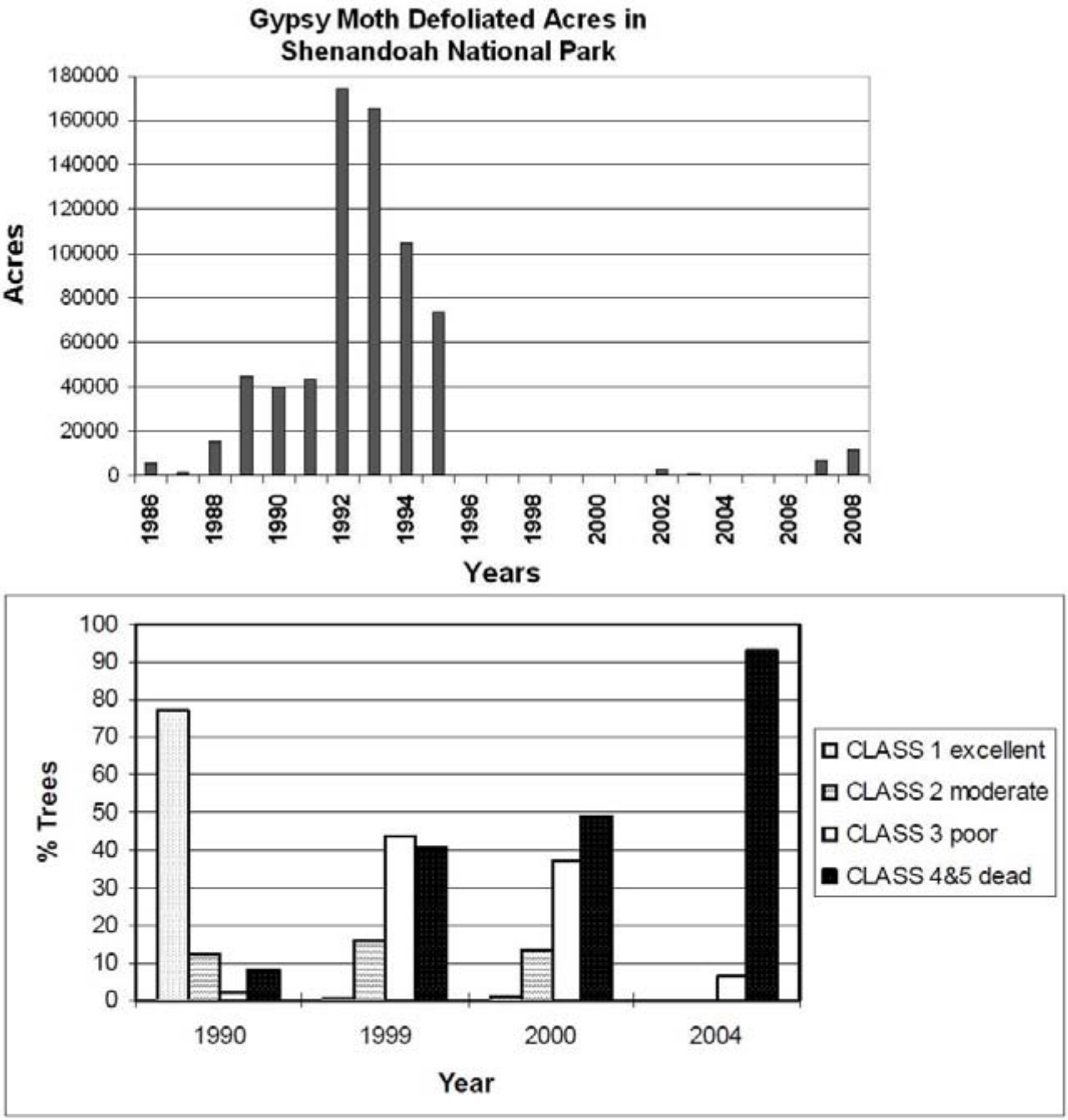

Figure 1. Comparison of crown health by year. Crown class is based on the percentage of foliage intact: Class 1: 90-100%; Class 2: 50-89%; Class 3: 1-49%; and Class 4 & 5: dead.